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The Scottish Whiting Fishery
in the North Sea
1955 - 1960

R. GAMBELL, B.Sc.

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DEPARTMENT OF AGRICULTURE AND FISHERIES
FOR SCOTLAND

MARINE RESEARCH

1963

No. 4

The Scottish Whiting Fishery
in the North Sea
1955 - 1960

By RAY GAMBELL, B.Sc.,

Marine Laboratory, Aberdeen

February, 1963

EDINBURGH: HER MAJESTY'S STATIONERY OFFICE

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The Scottish Whiting Fishery in the North Sea

INTRODUCTION

The whiting is one of the most abundant of the commercially important food fishes in the North Sea. The size of the fishery based upon it, and the importance of the North Sea grounds, which provide about half of the total quantity of whiting landed in Europe, have already been noted by Ellis and Jones (1956) and Messtorff (1959).

The whiting landed by Scottish vessels from the North Sea make up a large part of the total yield of the fishery by boats of all countries fishing in the area. Table I shows that the whiting landings in

TABLE I

PERCENTAGES OF THE TOTAL WHITING LANDINGS FROM THE NORTH SEA
TAKEN BY DIFFERENT COUNTRIES (FROM BULLETIN STATISTIQUE DES PÊCHES
MARITIMES)

	1955	1956	1957	1958	1959	Average
Scotland	45.9	49.0	40.1	48.6	43.5	45.4
France	26.6	28.3	24.6	29.3	24.6	26.7
Holland	7.7	7.9	6.5	9.2	12.6	8.8
Denmark	9.0	3.2	20.2	3.1	8.0	8.7
England	5.7	5.9	4.2	3.9	4.0	4.7
Belgium	2.7	2.5	2.1	2.7	2.9	2.6
Sweden	1.4	1.5	1.1	2.2	1.5	1.5
Germany	0.9	1.6	1.1	0.9	1.3	1.2
Norway	0.1	0.05	0.01	0.02	1.4	0.3
Total	72,436	74,943	84,314	77,484	80,491	77,934
(% from all areas)	57.2	60.4	58.8	56.9	49.7	56.6

Scotland during the period 1955 to 1959 represented between 40% and 49% of the total North Sea output, with an average of just over 45%. The second largest landings were made in France, with an average of nearly 27% of the total, followed by Holland and Denmark (each nearly 9%). These figures relate only to fish landed for direct human consumption, and do not include the whiting which occurred as a by-catch in the various industrial and 'mixed' fisheries. Investigations on the quantity of whiting caught in these fisheries, in which small-meshed nets are used, have been made by Blegvad (1946) and Jensen (1952) for the Danish industrial fishery, by Tiewis (1955, 1956) for the German oil-herring fishery and by Sahrhage (1957, 1958) for the German trawl herring fishery. The most important report on this subject, assembling all the available material, is that by the Lienesch Committee (1960).

In 1958 a programme for sampling the whiting landed by commercial vessels was started at Aberdeen. It was designed especially to investigate the size- and age-compositions of the landings, in order to build up a picture of the structure of the North Sea whiting stock and the Scottish fishery based upon it. The data from the market sampling work were also used to augment the landing and fishing effort statistics which were already available, and which have been used to follow the course of the fishery before 1958.

THE IMPORTANCE OF WHITING IN THE SCOTTISH FISHERY

Whiting is one of the four most important species of fish landed in Scotland from the North Sea. Figures available in the Scottish Sea Fisheries Statistical Tables (1955 to 1960) show that, in terms of the weight of fish landed, the whiting is the third most important species. Those which rank above it are herring and haddock, and it is followed by cod and plaice. In 1958, though, the whiting rose to second position because of the poor herring landings in that year.

When considered in terms of value, the positions of the main species are slightly altered, the whiting being a relatively cheap fish in Scotland, while haddock and cod are more valuable. Haddock and cod head the order of importance by value, but since 1956 whiting has risen above herring to occupy third place and, in fact, in 1956 whiting occupied second place.

Whiting is thus of considerable commercial importance in Scotland, but only since the last war, when the demand for all kinds of fish, including whiting, increased greatly. Before the war a good deal of the whiting caught was rejected at sea because it was of little value, but now all or most of the marketable-sized whiting are landed. For all that, fishermen do not generally set out specifically to catch whiting, preferring to concentrate their attention on the more profitable haddock, cod and plaice. The whiting they do catch are usually only incidental to their main interests, even though they may in fact form the bulk of their landings on occasion. This at least was so until about 1959, when the landings of more valuable fish, especially haddock, dropped to such a low level that any fish which could be marketed was sought. Then the fishermen did start to fish more specifically for whiting.

VESSELS AND METHODS OF CAPTURE

Almost all of the whiting landings from the North Sea in recent years have been made by steam and motor trawlers and seine-net vessels. Only very small and occasional landings, representing less than $\frac{1}{2}\%$ of the total, have been made by boats working other types of gear, such as great-lines and small- and hand-lines. Consequently they can be disregarded in a general survey of the fishery.

TABLE II

SCOTTISH WHITING LANDINGS AND FISHING EFFORT DATA FOR BRITISH VESSELS WORKING IN THE NORTH SEA
(SCOTTISH SEA FISHERIES STATISTICAL TABLES)

Year	Total wt landed (cwt)	Steam trawl			Motor trawl			Seine-net		
		wt (cwt)	% of total	hrs fishing	wt (cwt)	% of total	hrs fishing	wt (cwt)	% of total	days absent
1955	581,145	266,429	39.0	292,326	1,501	0.3	2,094	350,965	60.4	82,320
1956	642,976	222,516	34.6	265,832	8,923	1.4	7,879	408,811	63.6	87,675
1957	590,965	156,902	26.6	245,569	19,121	3.2	17,771	412,248	69.8	94,457
1958	659,038	171,672	26.0	281,501	40,095	6.1	41,539	446,029	67.7	83,636
1959	612,350	139,627	22.8	250,795	57,626	9.4	70,814	413,340	67.5	86,636
1960	489,965	43,695	8.9	114,879	46,441	9.5	114,424	398,397	81.3	87,586

The relative importance of the three main types of vessels engaged in the fishery can be seen in Table II. This shows that the seine-net fleet landed over 60% of the total weight of whiting taken from the North Sea each year, and in 1960 over 80%. A fairly constant fishing effort was attributable to the seine-net boats over the six-years period (1955-60) covered by the data. The corresponding steam and motor trawl effort figures, however, show very large changes, which reflect the transition in the Scottish

awling industry from steam to motor propulsion during this time. Motor trawlers were added to the North Sea fleet steadily during the period, but it was not until 1960 that a marked reduction occurred in the number of steam trawlers engaged. This accounted for the sharp fall in the 'hours fishing' recorded for that year, when most of the 'scratcher' fleet of old steam trawlers working on the local east coast grounds were scrapped, and were replaced by small, modern motor vessels.

NORTH SEA FISHING GROUNDS

The grounds worked by Scottish vessels extend over most of the northern North Sea, that is, from about latitude 55°N northwards to the edge of the continental shelf, and from the Scottish mainland, the Orkney and Shetland Isles eastwards to the western edge of the Norwegian Deep. Within this area most of the fishing activity is concentrated in the waters extending up to 100 miles or so from the Scottish east coast and the northern Isles. It is from these comparatively restricted coastal waters that the bulk of the landings are made which constitute nearly half of the total whiting landings from the entire North Sea by ships of all countries. This concentration of effort in a limited zone of the north-western North Sea is due not only to the fact that these waters are rich in fish, but also to the small size of many of the Scottish vessels. The seine-net boats are mostly less than 80 feet in length, and so tend to be confined to the more shore grounds, and many of the modern trawlers are also small.

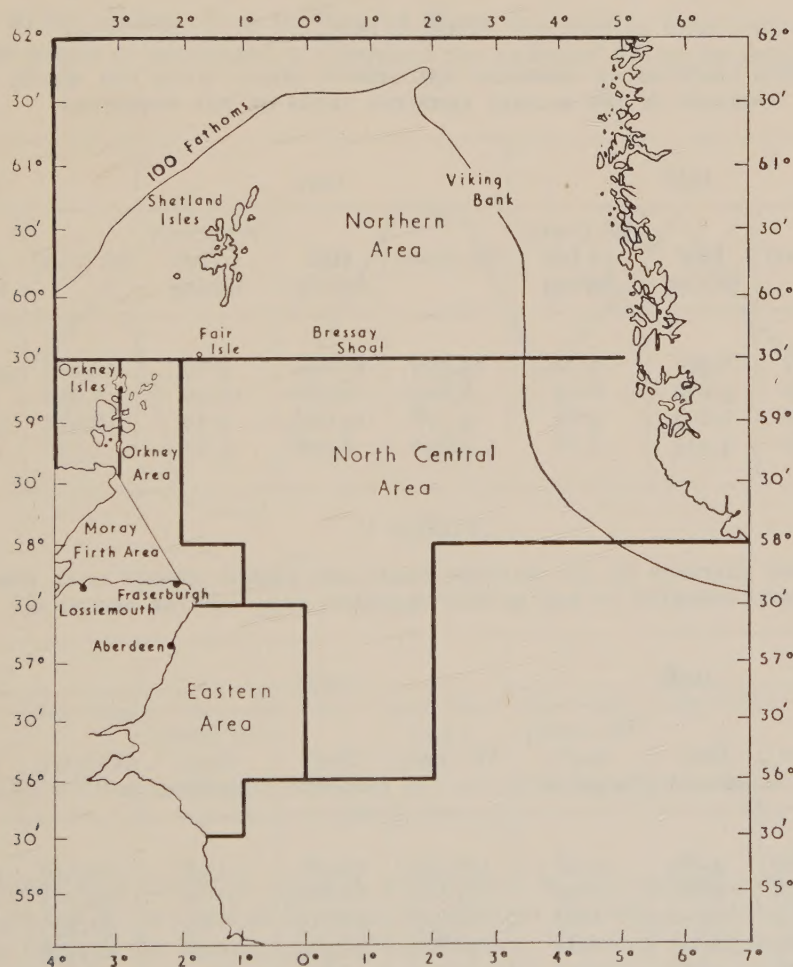


Fig. 1 Market sampling areas of the northern North Sea.

For the purpose of the market sampling programme, the northern North Sea was divided into five areas (see Fig. 1). The relative importance of each, as measured by the total weight of the whiting landings and the fishing effort expended by steam and motor trawlers and seine-net vessels, is shown in Tables III, IV and V.

TABLE III

ANNUAL WHITING LANDINGS AT ABERDEEN AND FISHING EFFORT DATA FOR STEAM TRAWLERS WORKING IN THE MARKET SAMPLING AREAS OF THE NORTH SEA

Area	1958			1959			1960		
	Wt (cwt)	Hrs' fishing	Wt (cwt)/ 10 hrs' fishing	Wt (cwt)	Hrs' fishing	Wt (cwt)/ 10 hrs' fishing	Wt (cwt)	Hrs' fishing	Wt (cwt)/ 10 hrs' fishing
Northern	28,146	59,919	4.70	27,434	67,540	4.06	8,787	19,038	4.62
North Central	26,748	30,006	8.91	20,076	22,788	8.81	2,923	5,212	5.61
Eastern	26,073	89,681	2.91	20,204	75,212	2.69	10,965	44,833	2.45
Orkney	20,830	45,824	4.55	8,294	21,154	3.92	1,815	8,193	2.22

TABLE IV

ANNUAL WHITING LANDINGS AT ABERDEEN AND FISHING EFFORT DATA FOR MOTOR TRAWLERS WORKING IN THE MARKET SAMPLING AREAS OF THE NORTH SEA

Area	1958			1959			1960		
	Wt (cwt)	Hrs' fishing	Wt (cwt)/ 10 hrs' fishing	Wt (cwt)	Hrs' fishing	Wt (cwt)/ 10 hrs' fishing	Wt (cwt)	Hrs' fishing	Wt (cwt)/ 10 hrs' fishing
Northern	3,767	6,581	5.72	13,333	16,002	9.17	15,126	32,003	4.73
North Central	4,592	5,632	8.15	8,604	6,670	12.90	2,958	7,403	4.00
Eastern	1,860	5,097	3.65	4,778	15,052	3.17	10,572	37,282	2.84
Orkney	2,560	4,475	5.72	3,652	6,506	5.61	3,536	11,674	3.03

TABLE V

ANNUAL WHITING LANDINGS AT ALL SCOTTISH PORTS AND FISHING EFFORT DATA FOR SEINE-NET VESSELS WORKING IN THE MARKET SAMPLING AREAS OF THE NORTH SEA

Area	1958			1959			1960		
	Wt (cwt)	Days absent	Wt (cwt)/ day's absence	Wt (cwt)	Days absent	Wt (cwt)/ day's absence	Wt (cwt)	Days absent	Wt (cwt)/ day's absence
Northern	115,620	9,264	12.48	136,852	10,987	12.46	124,359	11,735	10.60
North Central	156,834	13,888	11.29	131,803	12,890	10.22	142,227	14,056	10.12
Eastern	39,964	20,200	1.98	64,395	22,719	2.83	61,355	21,938	2.80
Moray Firth	55,503	30,647	1.81	38,844	30,367	1.28	28,358	31,716	0.90
Orkney	62,008	4,658	13.31	35,340	5,879	6.01	36,301	4,331	8.38

Most of the fishing in the northern area is concentrated around the Shetland Isles and Fair Isle, but some landings are made from more offshore grounds, such as Viking Bank and Bressay Shoal. In the years 1958-1960 the greatest weight of whiting landed by seiners per unit of fishing effort was from this area.

The North Central area is fished mainly off the north-east coast of Scotland by seine-net vessels. Steam trawlers worked here less frequently than in the Northern area, but the largest landings by steam trawlers per unit of fishing effort were recorded from the North Central area.

The Eastern area is fished extensively by both seine-net vessels and trawlers, and it was the area most heavily exploited by steam trawlers. Trawling by British vessels is not permitted in the Moray Firth, and so seine-net data only are available from this area. The Moray Firth area is the most intensively fished by seine-net vessels. The seine-net fishery in the Orkney area is, by contrast, small, and since the landings from this area are similar to those from the Moray Firth, for the purpose of the market sampling programme on seine-net landings, the two were combined to form a single area, the Moray Firth and Orkney area. For similar reasons of convenience of sampling and similarity between the landings, the samples from the trawl fishery in the Orkney area were added to those from the Eastern area, to form a single unit for trawl data, the East and Orkney area.

ANNUAL AND SEASONAL FLUCTUATIONS IN THE WHITING LANDINGS

The variations in the landings from the Scottish North Sea whiting fishery since the end of the war, measured by the weight of fish landed at Aberdeen per 10 hours' fishing by steam trawlers, are shown

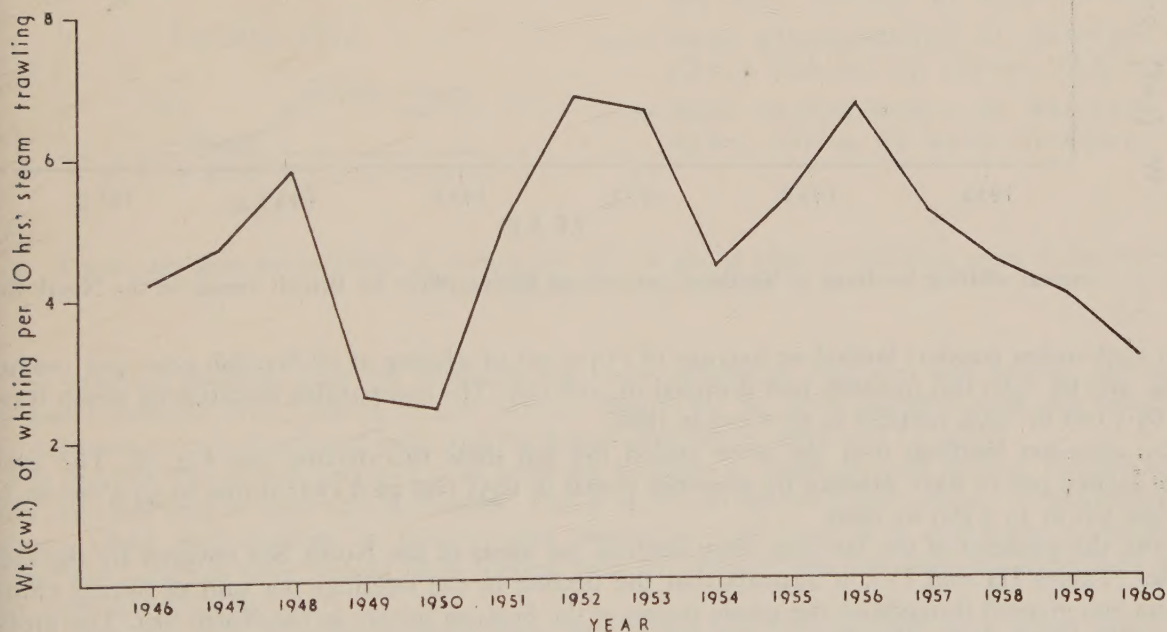


Fig. 2 Annual whiting landings at Aberdeen per unit of fishing effort by steam trawlers in the North Sea.

Fig. 2. The landings were lowest in 1949-50, and highest in 1952-53 and 1956. From 1956 to 1960 there was a steady decline in the landings by steam trawlers per unit effort, and this is also apparent from the figures given in Table II for landings at all Scottish ports. The data in Table II, when expressed in terms of weight of whiting landed per unit of fishing effort (Fig. 3), show that there was also a reduction in the landings by motor trawlers from 1956 to 1960.

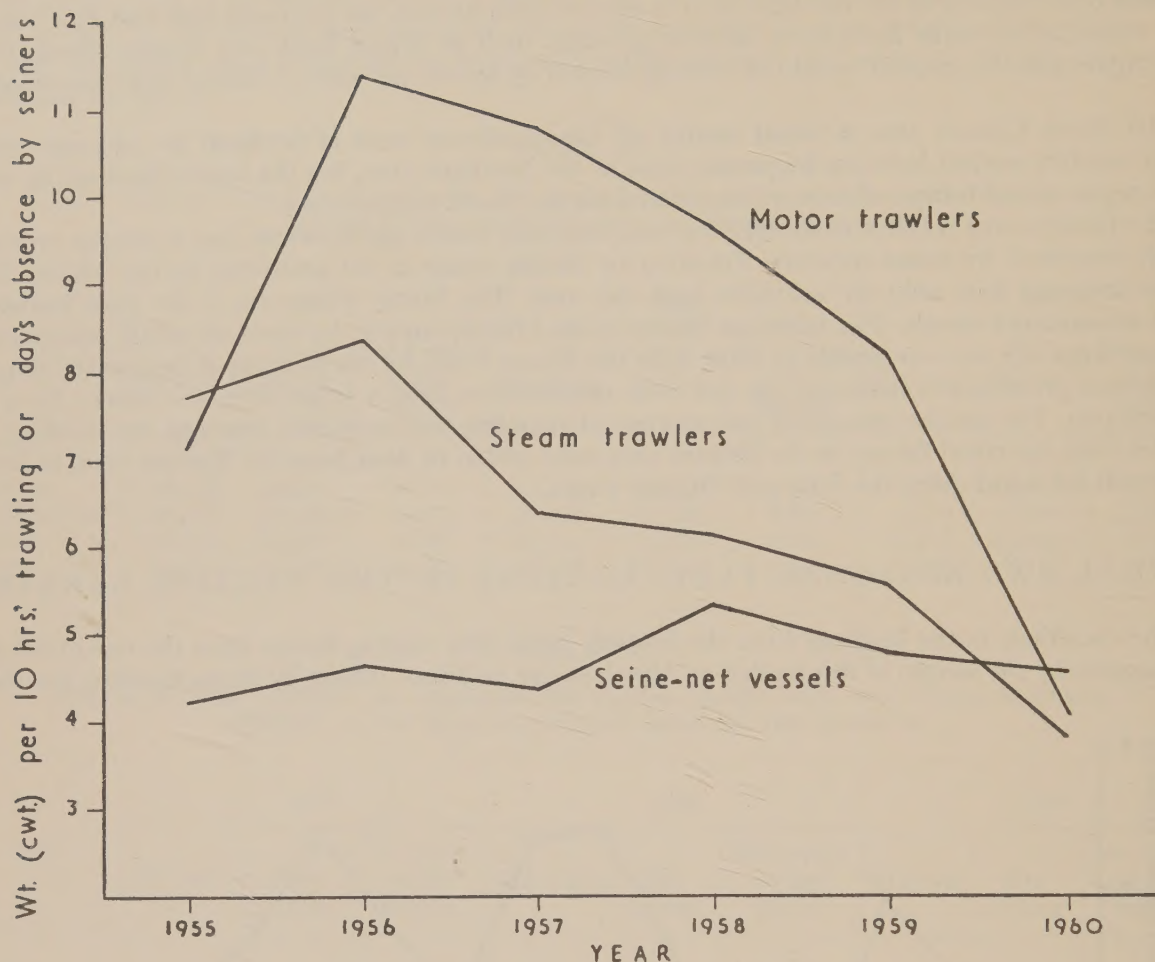


Fig. 3 Annual whiting landings in Scotland per unit of fishing effort by British vessels in the North Sea.

In 1956 motor trawlers landed an average of 113.3 cwt of whiting at all Scottish ports per 100 hours' fishing, and by 1960 this quantity had dropped to 40.6 cwt. The comparable landings by steam trawlers were 83.7 cwt in 1956, reduced to 38.0 cwt in 1960.

The seine-net landings over the same period did not show this decline (see Fig. 3). The average weight landed per 10 days' absence by seine-net vessels in 1955 was 42.6 cwt; it rose to 53.3 cwt in 1958, and then fell to 45.5 cwt in 1960.

From the statistics of the landings from each of the areas of the North Sea covered by the market samples (Tables III and IV), it appears that the decline in the landings per unit of fishing effort by trawlers was general throughout the whole region of the Scottish fishery in the North Sea. The probable causes of the decline are discussed in the next section, on year-class strengths.

The diagrams of the monthly landings from each area by trawlers and seiners per unit of fishing effort (Fig. 4) show very clearly the seasonal variations which occur in the whiting fishery in the different parts of the northern North Sea. Broadly speaking, the landings by the two fishing methods from all the areas can be divided into two groups. The trawl landings from all areas, together with the seine-net landings from the Northern and North Central areas, tend to have two peaks in each year. The seine-net landings from the remaining areas show only one. In Fig. 4, the monthly values for the three years 1958 to 1960 have been averaged to smooth out any excessive irregularities in the individual figures, and the following features of the landings are demonstrated.

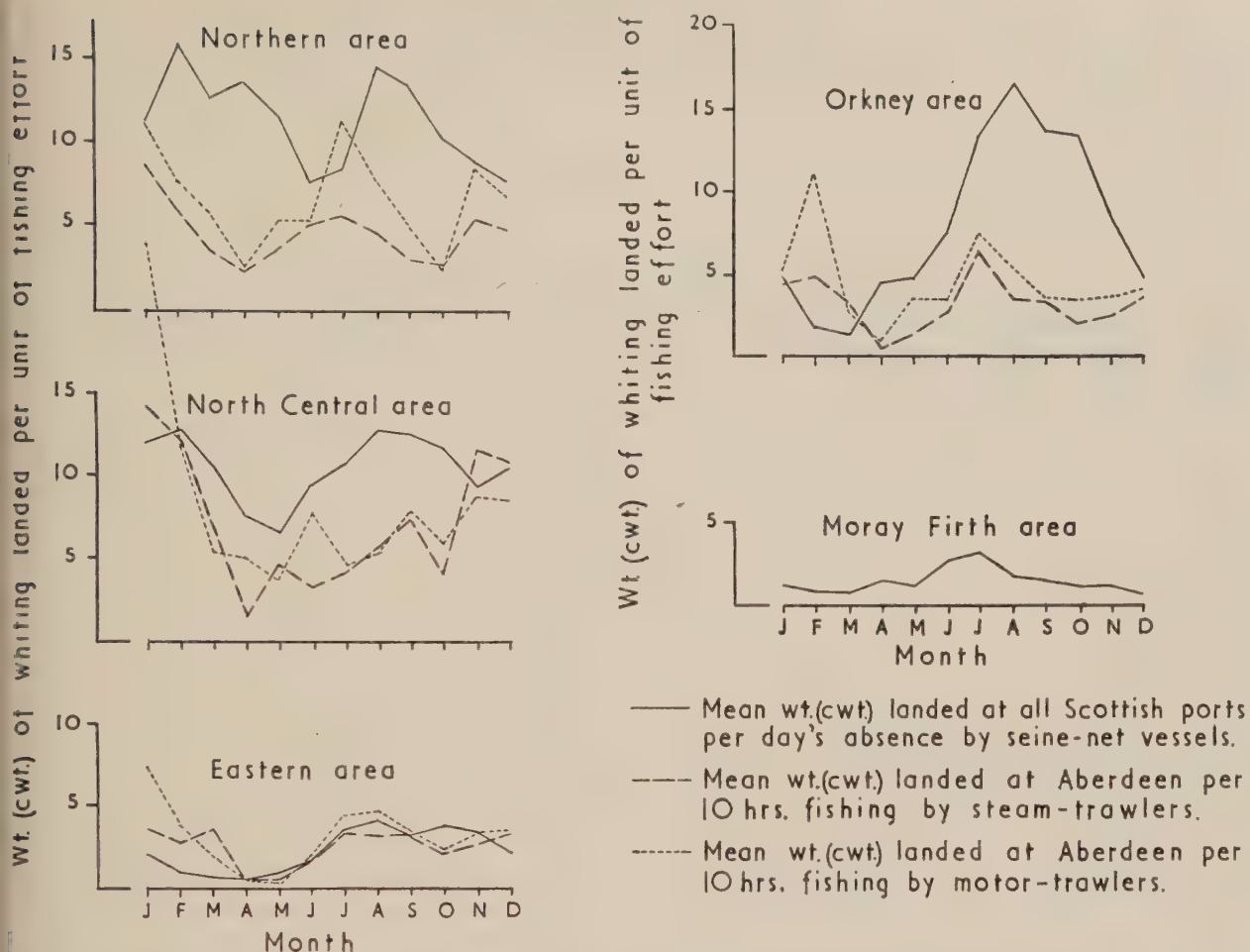


fig. 4 Trawl and seine-net landings of whiting per unit of fishing effort in different areas of the North Sea. Mean monthly values 1958-60.

The seine-net landings from the Northern area were greatest in February and August, and least in June and December. This cycle is moved forward slightly for the trawl landings from this area, which now peak values in January and July, and the lowest landings in April and October.

The North Central area also had peak seine-net landings in February and August, but the smallest values occurred here in May and November. This pattern was followed fairly closely by the steam-trawl landings, which had maxima in January and September and minima in April and October. The motor-trawl landings were also at their highest level in January, but rose and fell irregularly after a minimum value in May.

The fluctuations in the trawl landings from the Eastern and Orkney areas were rather similar. The biggest landings were made in February and July in Orkney and in January and July or August in the Eastern area. The landings did not build up to, or fall away from, these maxima so rapidly in the Eastern area as in all the other areas, resulting in fairly uniform landings over a number of months. The smallest value for the Eastern area was in May, and for Orkney in April.

The graphs of the seine-net landings for these two areas were also similar. Again, the Eastern area showed a number of months with almost equally high landings, with the heaviest in August and October. The peak in the Orkney area was also in August. Minimal landings appeared in Orkney in March, and in the Eastern area in April.

The cycle of fluctuations in the seinc-net landings from the Moray Firth was similar to those for the last two areas, but the difference between the highest and lowest values was much less. There was a summer fishery in the Moray Firth, with a peak in July, although the smallest landings were still in March.

YEAR-CLASS STRENGTHS AND THE FISHERY

It has been shown (Fig. 2) that the Scottish trawl whiting fishery in the North Sea has experienced some extensive changes in its fortunes since the end of the last war. Not only have there been good and bad years, but also there was the marked decline in landings from 1955 to 1960. These fluctuations require explanation, and this can be provided by reference to the strengths of the year-classes of whiting contributing to the fishery.

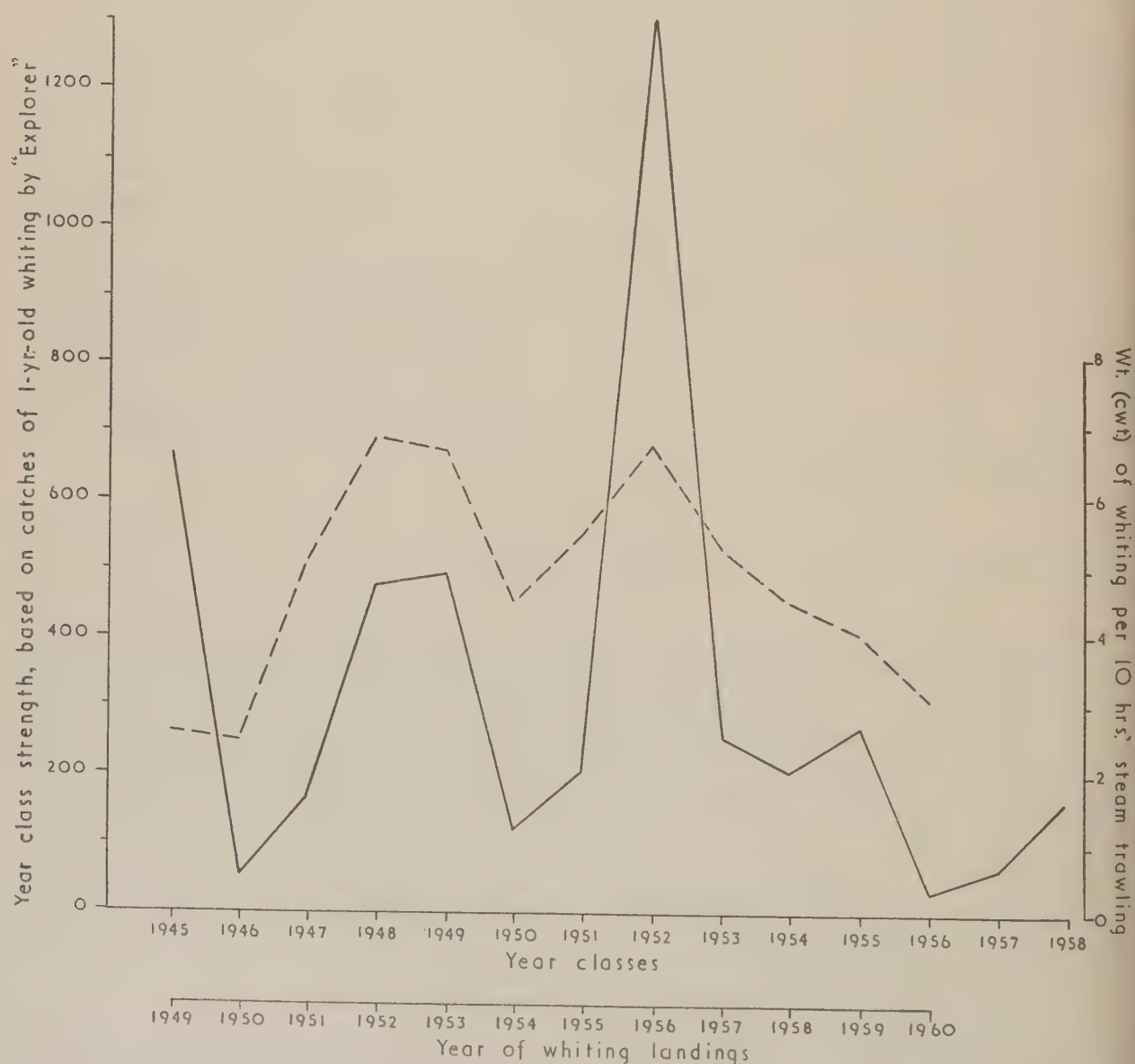


Fig. 5 Estimated year-class strengths of whiting in the northern North Sea. (Broken line shows the annual whiting landings at Aberdeen per unit of fishing effort by steam trawlers in the North Sea taken from Fig. 2).

Estimates of the whiting year-class strengths in the northern North Sea for the period 1930 to 1950 (excluding the war years) have already been published (Ellis and Jones, 1956). Unfortunately, it has not been possible to continue the assessments for later years exactly as before, since the area covered by the research vessel survey cruises on which they were based has changed in recent years. In addition, the surveys were taken over from the old "Explorer" in 1956 by the new "Explorer". Using a conversion factor obtained during the comparative fishing trials between the two vessels, the catches by the new ship have been reduced to the old standard, but because of the slightly different areas sampled the figures for both ships are not exactly comparable with the previously published data.

The present estimates are based on the catches of I-group whiting per unit of fishing time by the research vessels, using a cod-end with a small-meshed cover. From these, the average annual catches for the various sampling areas of the northern North Sea were calculated and then weighted by the size of each area. These areas were nearly identical with the market sampling areas (Fig. 1). The resulting values for the average annual catches of whiting in their second year of life, representing the estimates of year-class strengths, were then plotted (Fig. 5).

The main features of this graph are the outstanding size of the 1952 year-class, and the poor year-classes in 1946, 1956 and 1957. The most interesting result, though, is the fairly close correlation between the size of a year-class and the landings of whiting by trawlers at Aberdeen four years later (Fig. 2). This suggests that the poor landings in 1950 were due to the small year-class of 1946, and that the high level landings in 1952-53 and 1956 were due to the good year-classes of 1948-49 and 1952 respectively. On this basis, the decline in landings from 1956 to 1960 can be associated with the general reduction in year-class strengths from 1952 to 1956.

The analysis of the commercial landings by age shows that in terms of the numbers of whiting landed, each year-class makes its main contribution to the fishery between the ages of $2\frac{1}{2}$ and $3\frac{1}{2}$ years. It is therefore to be expected that the interval between the hatching of a year-class and its effect on the landings would be three years. However, the statistics of the fishery are based on the weight of whiting landed and not the number, and the main impact of a year-class in terms of the weight of fish landed is felt when the whiting are between $3\frac{1}{2}$ and 4 years old; this is demonstrated in the section on the weight-composition of the landings. It is this interval which accounts for the correlation between the strength of a year-class and the whiting landings by trawlers four years later.

The seine-net landings from 1955 to 1960 do not follow the trends in the year-class strengths so obviously. The seine-net vessels tend to fish the more inshore grounds, where the stock is made up of younger fish than that exploited by trawlers (see section on the age-composition of the landings). It might be expected, then, that the seine-net landings would follow the year-class fluctuations even more closely than those of the trawlers, but this is not so. There seems in fact to be little direct relationship between year-class strengths and seine-net landings.

METHODS AND SCOPE OF THE MARKET SAMPLING PROGRAMME

In February 1958 a sampling programme on whiting landed at the Aberdeen fish market was started. Aberdeen is the principal fishing port in Scotland, and so provides a good centre for sampling a large part of the fishery, covering most of the grounds worked by Scottish vessels. Three-quarters of the whole Scottish trawl fleet is based on the port, which also has its own fleet of seine-net vessels, but, as Ritchie (1960) pointed out, most seine-net landings at Aberdeen are made by boats from other ports. These vessels have usually made good catches on the local east coast grounds or at the more distant ones such as Shetland, and land them at Aberdeen because of the generally higher prices obtained there.

In order to include landings from as wide an area as possible, fish consigned for sale at Aberdeen from other ports were also sampled. These consignments were all seine-caught fish, landed mainly at ports in the Moray Firth, Shetland and south-east Scotland. This not only provided a relatively easy way of increasing the number of ports sampled, but also extended the range of fishing grounds covered by the market samples.

Initially a total of about 35 or 40 boxes, each containing eight stones of whiting, was measured each month on the Aberdeen market. In addition, one box a week was taken for otolith samples for age determination. From the age readings a monthly age-length key was constructed for estimating the age composition of the landings.

To cover the fishery in the Moray Firth and adjacent grounds more efficiently, direct sampling on the fish markets at Fraserburgh and Lossiemouth began in August 1959, in place of the sampling of consignments from these ports at Aberdeen. This enabled the sampling of direct landings at Aberdeen to be increased, by diverting to the direct landings the effort formerly used on consignments, and this increased programme at three ports continued for the rest of the period under review.

The data for each of the sampling areas were worked up, for trawlers and seine-net vessels separately, on a monthly basis. As the seine-net samples were reasonably representative of landings from the North Sea at all Scottish ports, the results were expressed finally in terms of the weight or the number of fish "per day's absence by seiners landing at all Scottish ports". For the trawl samples, the final units chosen were "per 10 hours' fishing by steam trawlers landing at Aberdeen".

As shown in the section on the annual and seasonal fluctuations in the whiting landings, there is little significant difference between the steam- and motor-trawl landings. The steam-trawl units have been used for convenience, and the results so expressed are also fully representative of the motor-trawl fishery.

AGE-COMPOSITION OF THE WHITING LANDINGS

The whiting landings from the various areas of the northern North Sea showed many similarities in age-structure and composition. The general pattern followed in both the trawl and seine-net landings is illustrated in Fig. 6 by monthly histograms of the seine landings from the North Central area in 1960. This can be taken as representative of the general form of the age composition. The recruit brood to the fishery usually makes its first appearance in the landings between the June and the September of its second year of life. In the illustration given, this is the 1959 year-class, first landed in July. Its contribution to the landings grows only slowly for the next year, but then increases rapidly to make its main impact at about the age of $2\frac{1}{2}$ years. By this time it is normally the largest single year-class present in the landings, and remains so for about twelve months. In the example, this phase of its progress in the fishery is represented in the last six months of the year by the 1958 year-class, and in the first six months by the 1957 year-class. It is the full entry of this recruit year-class to the fishery which accounts for the increase in landings per unit of effort in the Moray Firth area in the summer, and in all other areas in the autumn. After this peak contribution to the landings, the numbers of older fish gradually decline, and very few whiting more than 7 or 8 years old appear in the landings.

The variations in the age structure of the landings from one year to the next can be explained in the main by differences in the sizes of the various year-classes which are present in the exploited stock. Histograms of the age compositions of the landings in selected months are shown in Fig. 7, to illustrate the part played by each year-class and the main trends in the fishery from 1958 to 1960. The full details of the estimated numbers of fish in each year-class landed by steam trawlers and seine-net vessels from each area are given in the Appendix. From these data it can be seen that the seine-net landings usually contained a higher proportion of younger fish than those from trawlers. Otherwise the landings by the two types of vessel were very similar in each area.

Where possible, the age compositions of the landings in three months of each year have been illustrated in Fig. 7, one from the first quarter of the year, one from the summer period, and one from the last quarter. Lack of suitable samples has meant that no histograms are available for some periods from the North Central and the Moray Firth and Orkney areas.

From the remaining areas, it can be seen that the landings at the beginning of 1958 contained a large proportion of whiting belonging to the 1952 year-class (6 years old). This year-class was exceptionally strong to make such a large contribution to the landings at this late stage in its progress through the fishery. By the summer, the three-years-old fish (1955 year-class) were becoming increasingly important

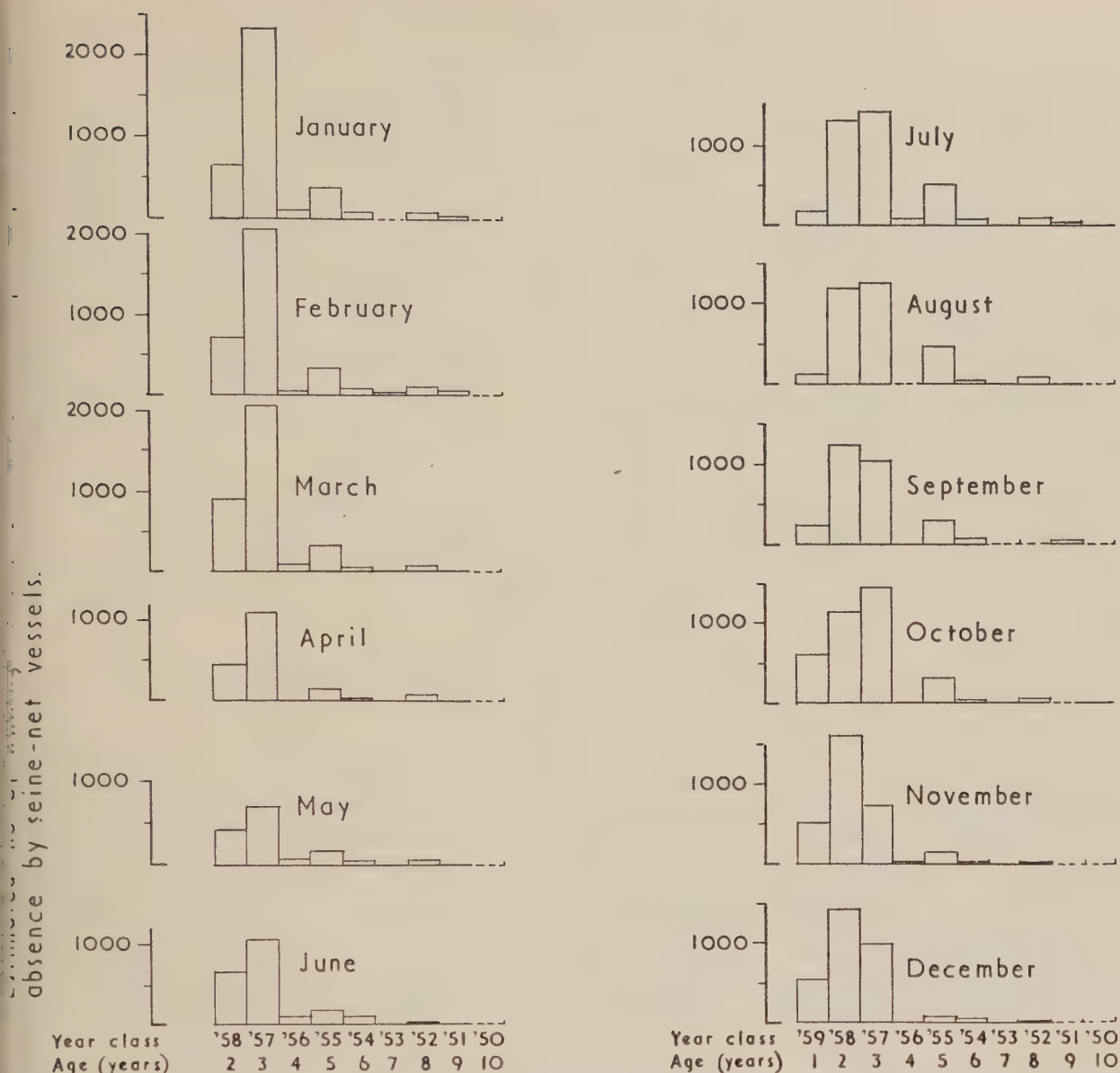
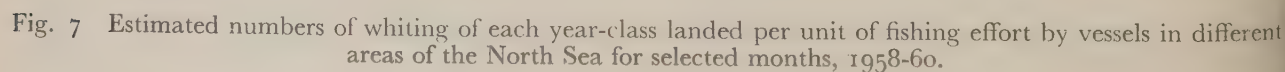


Fig. 6 Estimated numbers of whiting of each year-class landed at all Scottish ports per unit of fishing effort by seine-net vessels from the North Central area of the North Sea in each month of 1960.

the landings. The two-years-old whiting (1956 year-class) were playing a very minor role, so that by the end of the year they were even exceeded in numbers by the new recruit year-class (1957) in most landings. This unusual state of affairs was due to the fact that the 1956 year-class was very poor indeed and so contributed little to the fishery.

The 1955 year-class, the four-years-old whiting, dominated the landings in the early part of 1959, except those by trawlers from the East and Orkney area. There the two-years-old fish (1957 year-class) had become the largest age-group in the landings, a development found in the other areas later in the year—by the summer in seine-net landings from the Eastern, Moray Firth and Orkney areas, and by the autumn in the remainder. The 1956 year-class was scarcely represented, and this must be an important factor in the general decline in the level of the landings at that time.

At the beginning of 1960 the three- and five-years-old whiting (1957 and 1955 year-classes), in similar



umbers, were the main components of the landings from the Northern area; in other areas, however, the three-years-old fish were more important. By the summer or early autumn the two-years-old whiting (1958 year-class) began to figure prominently in the landings, and by the end of the year the fishery in all areas was based very largely on the 1957 and 1958 year-classes. The one-year-old fish (1959 year-class) also appeared in relatively large numbers, noticeably in the seine-net landings from the Eastern area and the Moray Firth and Orkney area.

Comparison of these data shows that the Scottish fishery in the North Sea is based on whiting of very similar age composition in each of the various areas. The same year-classes of fish were represented in the landings from all the areas, although the trawl landings from the East and Orkney area and the seine-net landings from the Moray Firth and Orkney and the Eastern areas tended to have a slightly greater proportion of younger fish in them than the corresponding landings from the Northern and North Central areas. Possible explanations for this difference lie in the facts that the areas contributing the landings of slightly younger whiting overall were both shallower and more heavily fished than the areas providing the landings of slightly older fish. Both of these factors have been suggested as possible causes for age differences which occur in the North Sea as a whole (Ellis, 1950; Ellis and Jones, 1956). If whiting move to deeper water as they grow older, this could account, at least in part, for the relatively greater numbers of older fish landed from the Northern and North Central areas, both of which are deep-water areas. Alternatively, or perhaps additionally, since the coastal grounds were more heavily exploited by both trawlers and seiners than the Northern and North Central areas, fewer old fish are likely to be found there than in the less heavily fished areas.

LENGTH-COMPOSITION OF THE WHITING LANDINGS

Analysis of the whiting landings by size of fish showed that the length-compositions in all the sampling areas were very similar. Histograms of the landings divided into five-centimetre size groupings are given for selected months in Fig. 8, but lack of suitable samples has meant that no histograms are available from the North Central and the Moray Firth and Orkney areas for some periods.

No major differences were observed between the length-compositions in each of the sampling areas. The shallow-water, heavily-fished coastal areas tended to have slightly fewer big fish than the Northern and North Central areas, for the same reasons as those considered above in the discussion of the age-compositions. The landings from the Northern area, especially those by seine-net vessels, tended to contain relatively fewer small fish than those from other areas. This agrees with figures obtained by research vessel sampling (Jones and Gamble, 1960; Gamble, 1961; Gambell, 1962, 1963 in press), indicating that there were fewer of the pre-recruit year-classes, and therefore fewer smaller whiting, in the Northern area than elsewhere in the northern North Sea.

The length data do not indicate any seasonal or annual changes in the length-frequencies, so that in all areas there must be a continual supply of small whiting coming into the fishery throughout the year to maintain the size-composition picture. A change which does appear from the data is an increase, from the autumn of 1959, in the proportion of whiting in the 25 to 29 cm size-range landed. This effect is especially noticeable in the seine-net landings, where, in all areas except the Northern, this size-group had become the dominant one by the end of the year. Even in the Northern area, the representation of this group of fish was much increased from this time onwards. The same trend is apparent in the trawl landings, but to a less marked extent.

The explanation for this change in the length-frequency distribution of the landings is provided by reference to the age-composition data already given. In the autumn of 1959 the 1957 year-class of whiting was beginning to make its main impact on the landings; the 1956 year-class was a particularly poor one, and the larger 1955 year-class was declining in numbers. The overall effect was a general reduction in the number of bigger, older fish in the landings and a greater reliance on the small fish of the new recruit year-class at this time. This trend continued in 1960, as the numbers of the large fish of the 1955 year-class declined still further, and the 1956 year-class contributed very little to the landings. The reverse

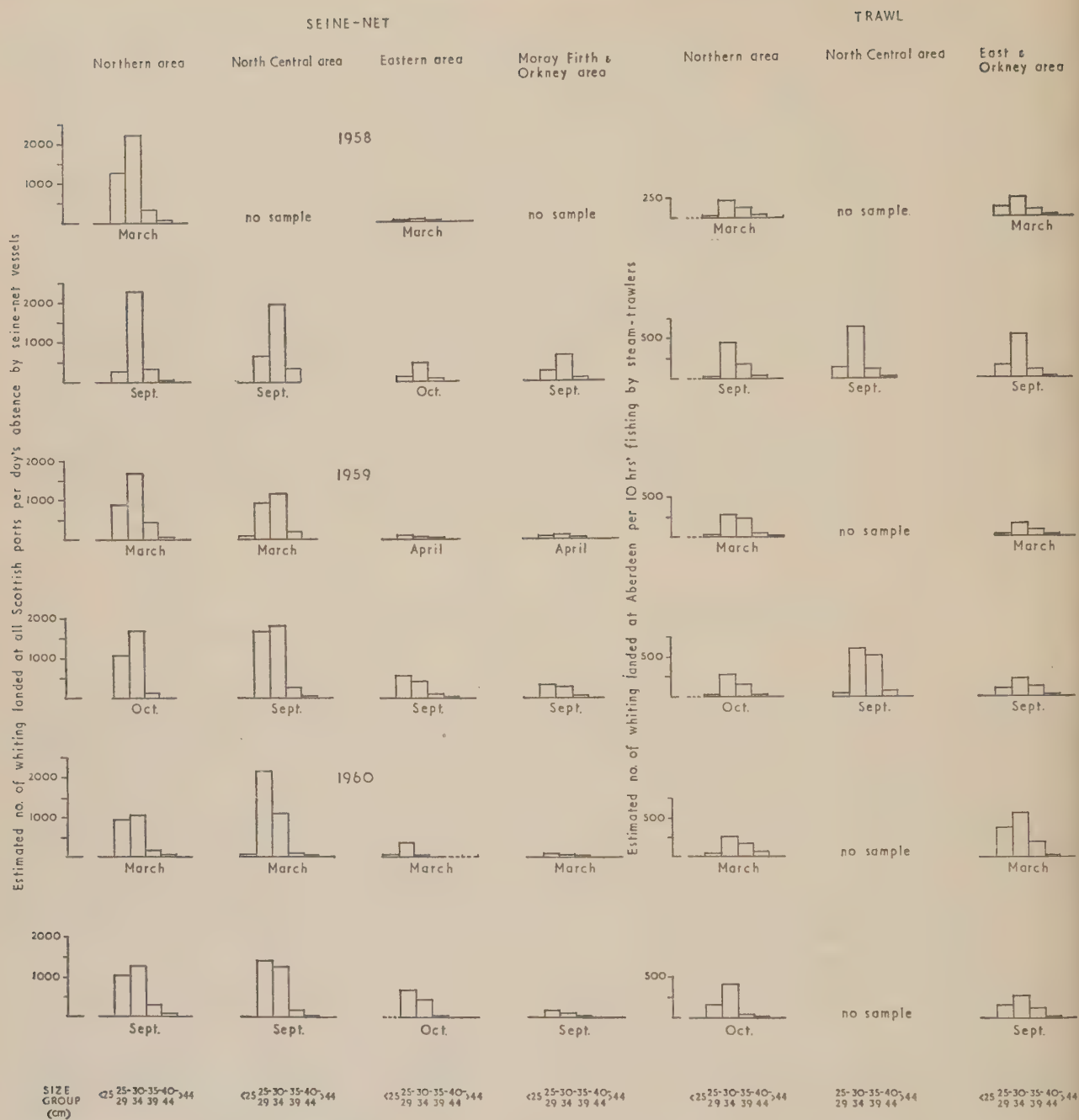


Fig. 8 Estimated numbers of whiting of each size-group landed per unit of fishing effort by vessels in different areas of the North Sea for selected months, 1958-60.

situation held in 1958, as the main recruit year-class in that year (1956) was very small, and the older fish of the very good 1952 year-class were providing many large whiting for the landings.

This change in the size-composition picture is reflected in the total annual whiting landings at Aberdeen, given in Fig. 9. These show very clearly the reduction in the numbers of large whiting and the increased number of small whiting landed by both trawlers and seine-net vessels since 1958. There was also an associated change in the modes of the length-frequency distributions. In 1958 the mode was at

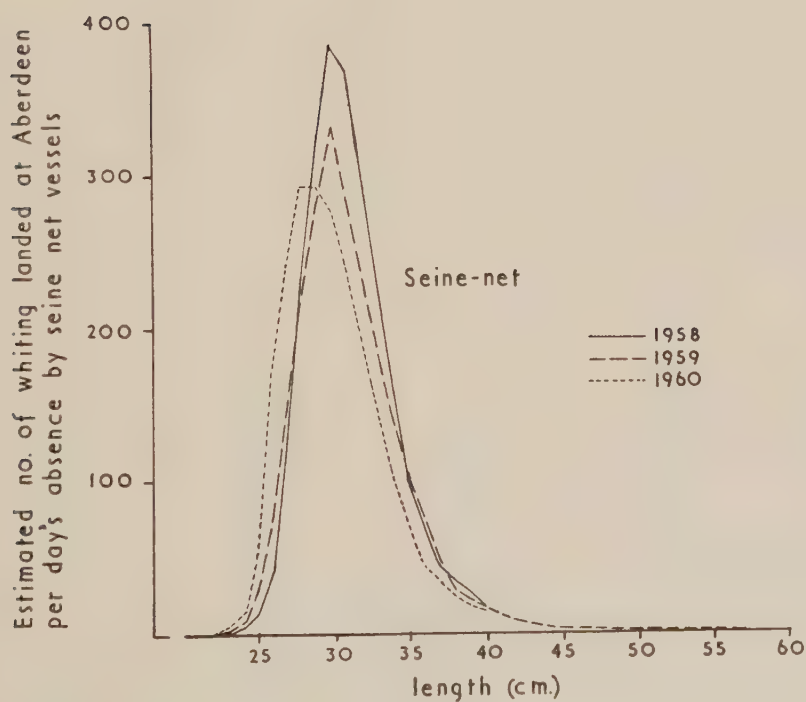
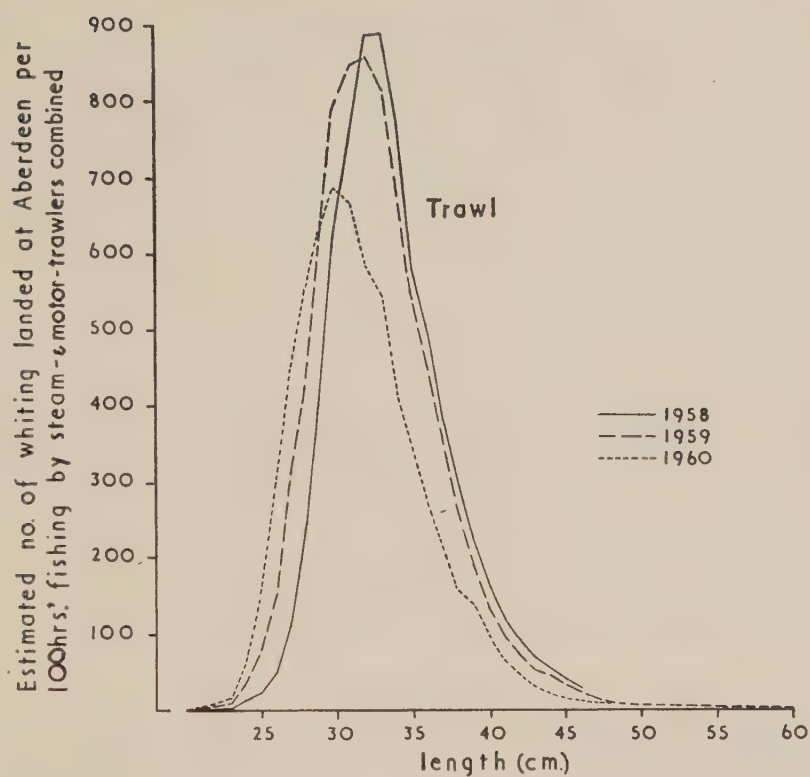


Fig. 9 Annual size-compositions of North Sea whiting landed at Aberdeen (from Fish Stock Record 1958-1960).

33 cm for trawl landings, in 1959 at 32 cm, and in 1960 it dropped to 30 cm. The seine-net landings show a smaller movement, from 30 cm in 1958 and 1959, to 28-29 cm in 1960.

These annual frequency distributions also illustrate the differences in the size compositions of the trawl and seine-net landings, the latter being composed generally of smaller fish. This may be partly attributable to the fact that the seine-net vessels tended to work on the more inshore and shallower grounds, where a smaller run of whiting are found. It may also be that the bigger, faster-swimming whiting can avoid a seine-net more easily than they can a faster moving trawl.

MORTALITY ESTIMATES

The market-sampling age-composition data provide suitable figures for estimating the total mortality coefficient (Z) of whiting in the northern North Sea. Values of Z were calculated by converting the numbers of fish landed per unit effort into logarithms, and averaging the differences between the same year-classes in successive years. The values obtained for the various areas are shown in Table VI.

TABLE VI

ESTIMATED TOTAL MORTALITY COEFFICIENTS (Z) FOR WHITING

From trawl landings				
Age \ Area (years) \	Northern	North Central	East & Orkney	
1-2	-4.36	-4.68	-1.94	
2-3	-1.03	0.51	0.40	
3-4	0.22	-0.35	1.71	
4-5	0.65	-0.21	1.41	
5-6	1.49	1.58	1.59	
6-7	1.02	0.36	0.84	
7-8	2.08	1.29	1.99	
Ave. 3-8	0.99	0.47	1.53	

From seine-net landings				
Age \ Area (years) \	Northern	North Central	Eastern	Moray Firth & Orkney
1-2	-2.91	-2.26	-1.95	-0.82
2-3	-1.27	-0.30	0.42	0.39
3-4	0.54	1.17	0.94	2.27
4-5	0.79	1.14	1.28	2.21
5-6	1.71	1.66	0.67	2.01
6-7	1.20	1.64	0.31	1.88
7-8	1.39	1.65	4.80	2.96
Ave. 3-8	1.12	1.43	1.44	2.03

TABLE VII

ESTIMATED VALUES OF Z FROM THE MARKET LANDINGS FOR THE NORTHERN NORTH SEA

Age (years)	1-2	2-3	3-4	4-5	5-6	6-7
Z	-3.17	-0.87	0.64	0.86	1.62	1.29

The youngest year-classes of fish were not fully represented in the landings, because their smallest members were less than the British minimum landing size of 25 cm. This produced apparently negative mortality rates for the youngest age-groups in the market samples. Therefore, to obtain a more realistic overall mean value for each area, only data from fish aged three years and older were used, since these age-groups appeared to be fully, or nearly fully, represented in the landings.

The most noticeable feature emerging from a comparison of these overall estimates of Z for the different areas is the very high figure of 2.03 obtained from the seine-net landings in the Moray Firth and Orkney area. The seine-net landings from the North Central and Eastern areas gave practically the same values, while the Northern area produced the lowest estimate (1.12) from the seine-net data. This last was slightly higher than the trawl figure for the Northern area. The estimate for the trawl landings from the East and Orkney area (1.53) was a little higher than the seine-net value for the Eastern area (1.44), but this could be due to the influence of the Orkney component. The trawl data from the North Central area were very limited, and the estimates derived for the mortality coefficients from age to age and overall are not considered to be sufficiently reliable for comparison with the others.

No immediate explanations to account for these differences between areas are available, but it is interesting that the lowest mortality rate occurs in the Northern area, and the highest in the Moray Firth and Orkney area. In the section on age-composition of the landings, the suggestion that whiting move into the deeper offshore areas from the coastal waters as they grow older was noted, and these mortality estimates could lend support to this theory. However, the Eastern area, which is also a shallow coastal area, tended to have a comparatively low Z when the high value for the 7-8 years old estimate was not included.

Another factor which may effect the apparent total mortality rate in a particular area, besides the possible movement of fish into or out of the area, is the fishing effort expended there. The data given in Tables III, IV and V give some indication of the amount of fishing carried on in the sampling areas. The trawl figures represent only the fishing effort by vessels landing at Aberdeen, and trawlers from other ports, as well as foreign vessels, were also working in the areas. Nevertheless, when the fishing effort per unit area based on these trawl and seine-net figures is calculated, it appears that the effort expended in the Moray Firth and Orkney area is roughly twice that expended in the Eastern area. This is necessarily an over-estimate of the ratio, but it does provide a further factor for consideration when seeking the cause of the high mortality in the Moray Firth and Orkney area.

Estimates of the total mortality coefficient for the whole of the northern North Sea can be derived from these figures for the sampling areas by weighing them according to their surface areas. When this is done, the estimate which is obtained from the seine-net data for whiting aged three years and older gives a value of $Z = 1.38$. Because of the limitations of North Central area trawl data, no separate estimate can be made from the trawl figures. The best over-all average values of Z between ages (excluding the unreliable North Central trawl values) are shown in Table VII.

THE WEIGHT-LENGTH RELATIONSHIP OF GUTTED WHITING

Using samples of whiting obtained from the Aberdeen market during the course of the sampling programme, it has been possible to study the relationship between the gutted weight and the length of whiting, and also the seasonal fluctuations which occur in the relationship.

Weekly samples of 50 fish were measured and weighed during 1959 and 1960. These samples came from the whole of the North Sea area fished by Scottish vessels, both trawl and seine, and no separation by areas or by method of capture was made. The resulting data were combined to obtain the average monthly gutted weight for each centimetre of length, on a minimum of five observations. Using these figures, and some additional data available from 1958 to 1961, the mean annual relationship between the length and the gutted weight of northern North Sea whiting was derived (Fig. 10).

When the average monthly weights obtained in 1959 and 1960 were plotted on a logarithmic scale against the lengths of the fish, also on a logarithmic scale, the points approximated very closely to a straight line, as in Fig. 10. The lines for each month, although they did not coincide exactly, were almost

parallel. To detect any regular seasonal patterns in the variations, the condition factor (k) from the formula:

$$k = \frac{100g}{l^3}$$

(where g = the gutted weight of the fish in gm, and l = its length in cm) was calculated for each length in each month.

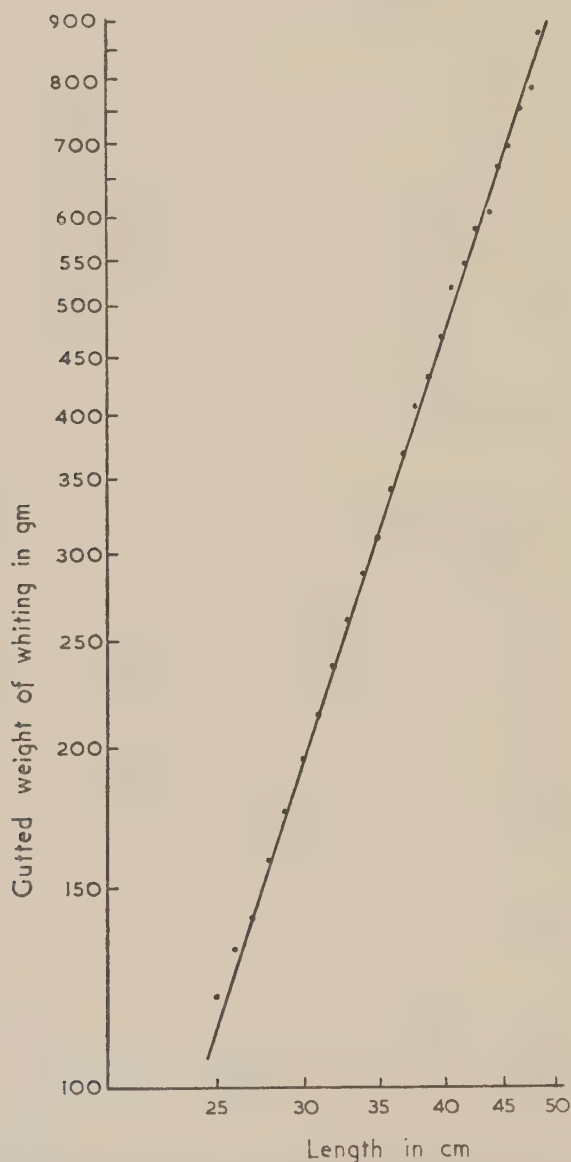


Fig. 10 Average annual relationship between the length and gutted weight of northern North Sea whiting.

It appeared that the relationship between the gutted weight and the cube of the length was not constant for all sizes of fish. Messtorff (1959) found that bigger ungutted whiting gave higher values of k than did small fish, and a similar, though not so well marked, tendency was observable in these data for gutted whiting. To overcome the resulting bias from this cause in making comparisons between months for which the length ranges of the data were not exactly similar, the mean values of k for various size ranges of fish were calculated.

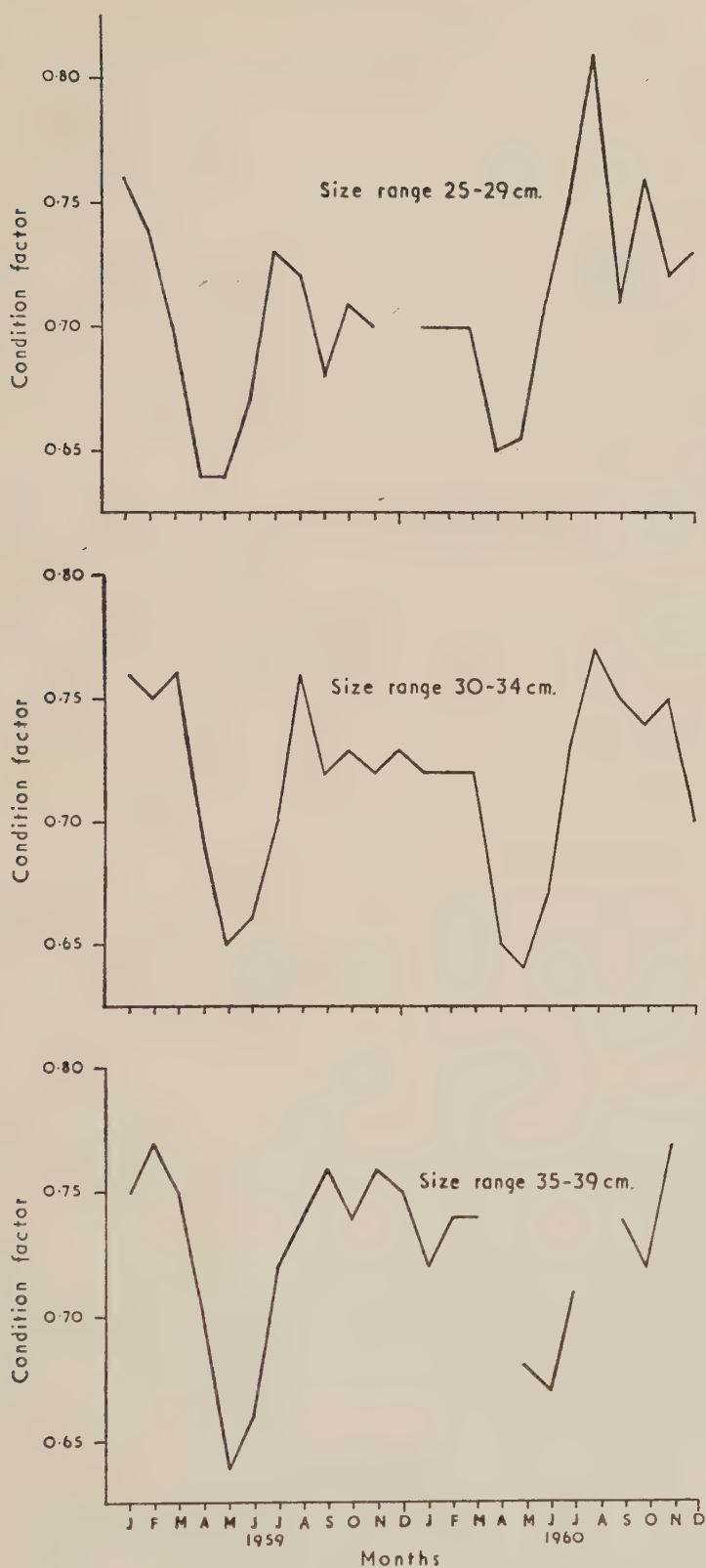


Fig. 11 Condition factor for gutted northern North Sea whiting

Unfortunately complete sets of figures were not available for every month of the two years of sampling, owing to the differing length-ranges of the samples, but the mean monthly values for three of the size groupings are given graphically in Fig. 11. These show a marked periodicity in the value of k each year for all the size-ranges of fish. Peak values occurred in the autumn (August-September), and minimal values in the spring (April-June). Such a rhythm suggests a connection with the annual maturation cycle of the whiting. The fish are in poor condition, that is, with their least weight of body material, immediately after spawning in the spring. In the autumn they build up the body weight to their best condition, in preparation for the next spawning season.

It is interesting to note that in both years investigated the spring minimum for the smallest fish was reached before that of the bigger fish. In 1959 it was in April compared with May for the larger fish, and in 1960 in April compared with May (30-34 cm range) and June (35-39 cm range). This may be an indication that the smaller, younger whiting spawn slightly earlier than the bigger, older fish. Male whiting are, on average, smaller than females of the same age and they also attain maturity before the females (Messtorff, 1959). These facts could be at least a part explanation of the earlier spawning tendency in small whiting compared with the large.

The seasonal fluctuations correspond closely to the pattern described by Messtorff for whole, ungutted whiting in the North Sea. This means that not only does the total weight vary with the maturity stage of the fish, but so also does the consumable body weight. It might have been expected that the major weight changes occurring during the year would be due to the development and subsequent emptying of the gonads, and undoubtedly this must play a part in the total weight changes. But this still leaves a significant difference between the gutted weight of a whiting in peak condition, and one at its period of least weight. The data indicate, in fact, that the maximum weight averages from 15% to 20% more than the minimum at each length.

WEIGHT-COMPOSITION OF THE WHITING LANDINGS

It has been noted, in discussing the correlation between year-class strength and the trawl landings at Aberdeen four years afterwards, that the main effect of a year-class on the landings in terms of the weight of fish landed occurs after the time when the maximum numbers of the year-class are present. This effect can be illustrated by examining the idealised structure of the whiting landings, to eliminate the effects of the varying year-class strengths.

Using the average values of Z between ages given in Table VII the theoretical numerical composition of the combined trawl and seine-net landings by age was derived, taking the number of II-group whiting as 100. This composition is illustrated in Fig. 12. The mean length of each age group was then obtained by weighting and combining the mean lengths available from the market sampling data. Using Fig. 10, these mean lengths were converted into average weights, and the weights were multiplied by the theoretical numbers of each age-group present in the idealised landings. This gave the weight-composition of the landings shown in Fig. 13.

Comparison of Figs. 12 and 13 demonstrates the greater part played by the older fish in the landings when weight instead of numbers is considered. Although the three-years old whiting are the best represented in both pictures, the four-years-old fish are much more evident by weight than by number, and the five-years-old whiting are nearly as important by weight as the two-group fish, although only about half as numerous.

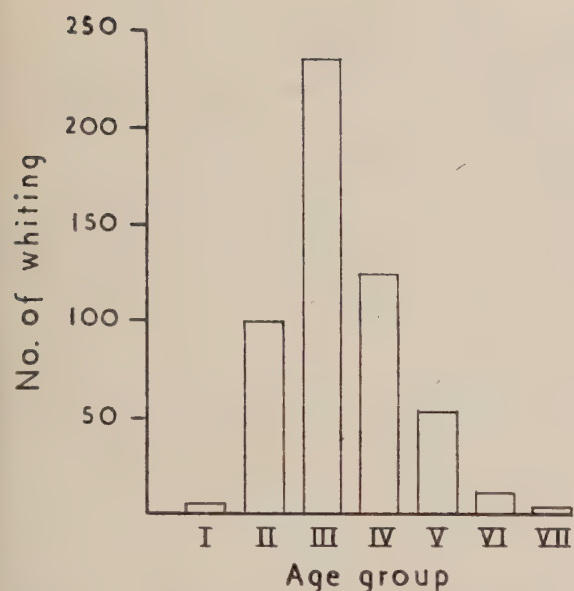


Fig. 12 Idealised landings of whiting from the northern North Sea, by numbers of fish.

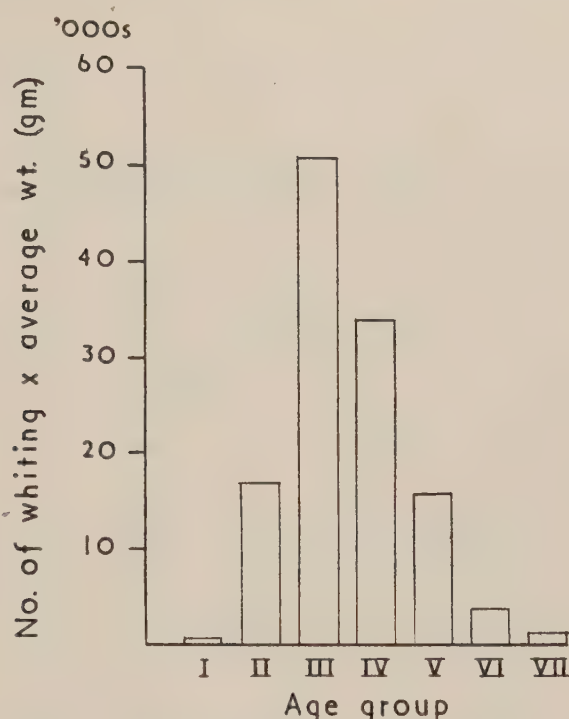


Fig. 13 Idealised landings of whiting from the northern North Sea, by weight of fish.

SUMMARY

Scottish whiting landings from the North Sea are the largest by any country and in Scotland the whiting is the third most important species taken from this area. The Scottish fishery is conducted almost entirely by trawlers and seine-net vessels working in the north-western part of the North Sea, and the commercial landings have been sampled to build up a picture of the fishery and the stock which is exploited.

The fluctuations in the landings are discussed, and a correlation between the strength of a year-class and the whiting landings by trawlers four years later is demonstrated. Through the data collected in the market sampling programme carried out from 1958 to 1960, the age-structure and composition of the whiting landings are investigated. The impact of each new recruit year-class on the fishery is traced, together with its influence resulting in the seasonal fluctuations which occur in the landings. The size-composition data from the landings are also analysed, and show that a reduction in the numbers of large whiting, and an increase in the numbers of small whiting occurred from 1958 to 1960. This change is explained on the basis of the strengths of the various year-classes contributing to the landings.

From the age-composition data, mortality estimates for whiting in the northern North Sea are derived. Higher values are obtained for the shallow coastal areas than the deep off-shore areas. This may indicate that whiting migrate from one to the other as they grow older, an idea suggested by the age- and length-compositions of the whiting landed from the various areas. The fishing effort expended in each sampling area may also affect the different mortality rates obtained. The overall estimate of the total mortality coefficient for the northern North Sea is calculated as $Z = 1.38$.

The mean annual relationship between the length and the gutted weight of northern North Sea whiting is derived, and a possible connection between the maturation cycle and the seasonal fluctuations in the condition factor for gutted whiting is noted. The idealised weight-composition of the whiting landings is illustrated, and compared with their theoretical numerical composition.

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APPENDIX

AGE-COMPOSITION DATA FOR MARKET LANDINGS OF WHITING

NORTHERN AREA: NUMBER OF WHITING OF EACH YEAR-CLASS LANDED PER 10 HOURS' FISHING
BY STEAM TRAWLERS AT ABERDEEN

1958

Year class	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
57	—	—	—	—	—	—	—	—	8.3	3.6	—
56	—	—	0.3	—	32.8	—	44.9	2.1	3.3	—	5.5
55	163.4	43.5	63.0	844.5	404.9	250.6	905.5	30.7	164.5	236.4	333.6
54	209.5	82.9	91.4	347.8	111.6	150.3	253.1	172.0	59.0	110.6	190.4
53	127.7	66.0	71.7	214.6	235.0	132.5	127.7	52.9	59.6	2.6	15.5
52	440.5	159.0	190.3	330.7	602.7	606.5	285.7	138.6	42.8	445.1	411.3
51	121.0	100.2	35.6	40.3	47.7	151.2	80.5	37.0	14.6	64.9	75.8
50 & earlier	—	11.2	4.2	11.2	10.0	27.7	—	—	—	—	—

1959

Year Class	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Oct.	Dec.
1958	—	—	—	—	—	—	3.4	—	2.1	—
1957	—	56.7	17.5	50.6	68.8	42.9	300.3	132.2	222.1	359.9
1956	—	42.6	23.0	36.7	19.3	16.4	26.0	21.3	13.9	37.4
1955	924.5	295.0	340.0	252.9	300.0	382.2	424.8	332.8	169.6	318.9
1954	320.5	143.4	88.6	55.4	95.3	137.2	112.1	70.6	62.8	78.3
1953	54.8	36.2	24.0	36.5	22.3	57.1	57.3	18.6	9.4	10.3
1952	117.1	84.4	127.9	96.5	85.7	140.5	122.6	95.7	60.8	101.5
1951 & earlier	30.0	6.2	8.2	3.9	4.5	10.0	10.3	20.8	5.0	10.5

1960

Year class	Jan.	Feb.	Mar.	Apr.	May	July	Oct.	Nov.	Dec.
1959	—	—	—	—	—	—	63.5	5.5	45.7
1958	334.4	155.3	33.6	44.6	79.2	474.0	267.2	74.4	211.0
1957	1386.4	684.5	233.0	115.1	111.7	397.4	271.3	137.2	232.3
1956	112.5	103.0	17.3	3.4	7.1	6.0	1.5	—	41.8
1955	612.1	580.2	196.1	60.2	66.0	292.5	29.4	28.6	53.7
1954	—	115.8	44.3	14.5	10.9	24.0	4.5	3.9	5.8
1953	13.7	38.8	16.8	8.5	5.6	12.7	1.5	—	—
1952 & earlier	11.3	114.5	42.1	19.6	17.0	13.8	4.0	—	0.6

EAST AND ORKNEY AREA: NUMBER OF WHITING OF EACH YEAR CLASS LANDED PER 10 HOURS¹
FISHING BY STEAM TRAWLERS AT ABERDEEN

1958

Year class	Feb.	Mar.	May	July	Aug.	Sep.	Oct.	Nov.	Dec.
1957	—	—	—	—	25.4	20.6	15.4	196.9	28.5
1956	—	2.5	6.4	89.8	32.9	73.1	113.9	28.0	23.9
1955	371.0	172.7	179.7	552.8	644.7	617.6	340.4	276.5	490.7
1954	91.9	166.5	68.9	82.3	121.7	50.4	86.9	55.7	139.9
1953	146.7	110.9	10.1	27.1	20.9	8.2	5.6	9.6	10.3
1952	148.4	255.2	105.6	197.0	89.2	75.2	70.4	110.1	102.4
1951	23.9	91.7	19.9	13.0	270.7	13.3	50.5	29.1	—
1950 & earlier	9.1	6.0	0.8	—	1.3	2.0	—	2.8	—

1959

Year class	Jan.	Feb.	May	June	Aug.	Sep.	Oct.	Nov.	Dec.
1958	—	—	1.8	—	67.2	12.4	8.7	13.5	105.6
1957	205.1	401.5	177.9	353.9	320.9	190.7	201.9	245.1	651.7
1956	51.8	78.4	10.5	53.8	16.6	20.5	17.4	24.1	105.6
1955	512.8	301.0	34.0	100.0	151.2	163.3	166.5	177.6	74.5
1954	128.8	32.0	8.3	17.5	17.0	26.1	28.9	20.8	—
1953	12.2	5.6	—	2.0	4.5	5.2	8.3	5.5	—
1952	247.7	96.3	13.8	49.1	35.7	66.0	33.2	54.1	—
1951 & earlier	25.9	15.4	1.8	15.4	1.6	3.7	7.4	13.7	—

1960

Year class	Jan.	Feb.	Mar.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1959	—	6.9	—	—	35.1	67.5	212.9	58.1	32.4	165.1	54.7
1958	110.7	105.0	111.8	43.7	138.4	407.7	266.0	169.7	57.9	102.2	135.5
1957	416.9	423.3	816.9	96.4	147.1	366.0	165.0	274.4	82.4	112.0	129.6
1956	15.6	13.4	46.4	1.9	3.1	0.6	7.0	4.3	1.8	2.7	0.6
1955	118.5	69.3	118.7	21.6	21.0	20.3	14.5	44.9	29.8	28.2	21.8
1954	7.1	5.8	6.6	4.1	4.5	—	0.3	4.0	6.6	—	0.6
1953	4.6	—	—	—	0.7	—	—	2.4	—	—	—
1952 & earlier	23.7	112.4	14.4	14.2	6.0	5.4	—	5.6	0.9	0.9	3.0

NORTH CENTRAL AREA: NUMBER OF WHITING OF EACH YEAR-CLASS LANDED PER 10 HOURS'
FISHING BY STEAM TRAWLERS AT ABERDEEN

1958

Year class	Aug.	Sep.	Oct.	Nov.	Dec.
1957	—	10·8	—	2·1	6·2
1956	41·1	51·7	—	—	9·3
1955	873·8	659·0	561·5	221·9	556·3
1954	84·9	116·9	163·3	114·7	374·5
1953	74·2	16·6	63·3	0·6	34·8
1952	128·7	92·4	333·5	655·4	672·6
1951	15·9	8·7	59·2	137·9	93·5
1950 & earlier	—	—	—	—	—

1959

Year class	Aug.	Sep.	Nov.
1958	1·0	4·2	122·4
1957	123·2	314·9	836·4
1956	18·6	41·5	202·1
1955	638·4	665·7	859·9
1954	108·5	84·5	235·2
1953	67·4	25·0	50·2
1952	216·9	155·9	206·9
1951 & earlier	5·6	4·5	16·0

NORTHERN AREA: NUMBER OF WHITING OF EACH YEAR-CLASS LANDED PER DAY'S ABSENCE
BY SEINE-NET BOATS AT ALL SCOTTISH PORTS

1958

Year class	Mar.	April	May	June	Sept.	Oct.
1957	—	—	—	—	—	262.1
1956	—	—	—	137.2	16.6	80.5
1955	940.5	1113.4	1368.3	960.0	1536.8	1905.2
1954	1141.8	818.9	657.8	168.7	713.1	419.4
1953	621.8	398.4	454.7	269.2	194.6	103.5
1952	704.7	998.9	907.4	593.7	436.8	91.6
1951	386.4	120.3	74.5	64.1	82.5	—
1950 & earlier	62.5	16.6	21.8	9.9	—	—

1959

Year class	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Oct.
1958	—	—	—	—	—	—	5.2	—	67.4
1957	58.6	417.7	430.1	502.1	198.6	107.2	490.6	1410.3	2378.3
1956	14.0	116.8	170.1	343.5	119.2	40.3	42.8	151.4	66.8
1955	1019.8	1786.6	1763.2	1550.0	1436.5	826.6	784.0	1567.9	358.0
1954	423.0	600.8	343.8	291.4	388.8	265.4	222.5	268.4	116.0
1953	51.0	137.1	51.4	97.6	102.1	97.7	116.4	45.6	5.5
1952	127.6	265.8	279.0	434.0	240.1	269.6	251.9	202.4	37.1
1951 & earlier	11.5	8.3	18.1	17.1	9.8	22.1	22.3	43.2	5.7

1960

Year class	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1959	—	—	—	—	—	—	—	87.5	118.7	196.1	69.7	150.2
1958	269.3	644.2	424.3	1023.9	734.0	131.8	319.4	873.4	1567.4	735.3	558.4	784.6
1957	2496.3	2022.6	1194.2	1694.1	1171.6	707.7	513.1	1320.0	729.9	709.9	594.9	684.8
1956	217.2	175.1	26.5	47.3	36.6	44.5	11.2	—	25.3	3.0	—	61.8
1955	964.9	799.5	404.3	599.2	519.0	429.9	590.8	670.8	351.4	71.0	43.2	109.7
1954	—	144.5	49.7	130.5	89.7	85.8	44.9	27.0	47.4	11.7	7.4	3.1
1953	2.9	23.5	19.8	47.1	25.1	28.7	38.0	13.1	14.6	3.0	—	—
1952 & earlier	—	79.2	53.9	102.8	56.7	100.9	32.9	119.6	24.0	11.0	—	3.1

NORTH CENTRAL AREA: NUMBER OF WHITING OF EACH YEAR-CLASS LANDED PER DAY'S
ABSENCE BY SEINE-NET BOATS AT ALL SCOTTISH PORTS

1958

Year class	July	Aug.	Sept.	Oct.	Nov.	Dec.
1957	—	—	119.9	115.5	103.1	430.8
1956	39.6	103.5	219.3	208.7	—	80.3
1955	876.9	2091.2	2059.6	1606.8	1516.7	861.2
1954	331.0	365.8	299.1	256.7	484.1	462.0
1953	206.1	253.6	53.2	106.5	80.7	28.0
1952	911.8	410.5	248.0	385.3	479.3	609.0
1951	245.7	49.4	27.0	72.9	46.2	65.0
1950 & earlier	33.6	—	—	—	—	—

1959

Year class	Mar.	May	July	Aug.	Sept.	Oct.	Nov.	Dec.
1958	—	—	—	66.3	152.9	169.6	38.0	657.0
1957	755.4	357.5	339.6	993.1	2094.4	1576.7	630.0	2052.3
1956	61.6	220.5	119.9	58.2	134.6	57.5	62.5	38.7
1955	1311.2	1010.1	1477.9	1577.7	1078.7	903.8	495.0	198.4
1954	52.3	216.3	201.6	290.5	141.3	261.5	126.2	10.3
1953	1.0	37.6	71.7	54.7	33.5	29.5	19.5	3.1
1952	167.6	123.3	96.5	269.1	189.8	136.1	78.7	27.6
1951 & earlier	15.8	11.4	31.6	27.6	9.5	10.9	5.1	3.3

1960

Year class	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1959	—	—	—	—	—	—	164.9	117.9	226.6	607.1	581.5	488.7
1958	678.8	682.9	834.3	466.3	402.6	680.6	1320.6	1255.0	1254.6	1172.1	1607.2	1467.0
1957	2372.0	2114.2	2132.2	1127.6	787.8	1072.0	1408.9	1335.7	1086.6	1460.9	774.3	966.1
1956	108.0	48.0	121.6	9.2	26.6	33.0	55.3	—	8.2	9.9	24.5	0.8
1955	383.9	318.0	366.9	155.0	194.5	178.5	497.2	494.8	314.7	289.5	176.3	69.8
1954	35.0	107.5	22.6	17.0	12.2	45.9	24.2	19.2	46.7	6.9	19.6	7.7
1953	—	12.5	0.4	5.5	2.4	1.5	11.1	4.0	—	4.4	9.6	0.6
1952 & earlier	102.7	129.5	32.9	47.6	23.0	9.2	72.3	63.5	19.4	13.8	13.8	4.5

EASTERN AREA: NUMBER OF WHITING OF EACH YEAR-CLASS LANDED PER DAY'S ABSENCE
BY SEINE-NET BOATS AT ALL SCOTTISH PORTS

1958

Year class	Mar.	May	July	Aug.	Oct.	Nov.
1957	—	—	—	11.0	22.2	469.3
1956	0.5	10.1	35.2	30.1	87.0	53.3
1955	34.2	54.5	415.9	603.5	398.9	139.7
1954	20.5	22.9	51.2	126.6	80.7	8.9
1953	7.6	1.8	18.5	21.4	3.6	0.3
1952	28.8	52.6	49.3	75.2	43.5	4.4
1951	9.1	18.7	5.3	32.9	46.2	3.1
1950 & earlier	1.1	0.7	—	1.7	—	—

1959

Year class	Jan.	June	Aug.	Sept.	Oct.	Nov.	Dec.
1958	—	—	96.4	72.9	14.7	109.5	235.9
1957	40.0	307.8	594.8	748.0	767.2	599.5	530.6
1956	3.7	53.7	62.1	46.2	30.9	29.3	4.8
1955	82.0	128.0	83.8	188.2	287.6	193.2	9.0
1954	21.9	37.7	14.6	10.4	42.0	21.9	—
1953	1.9	3.0	—	3.4	9.8	5.4	—
1952	41.3	104.9	—	26.0	27.3	53.5	—
1951 & earlier	5.2	21.7	—	2.8	17.8	13.6	—

1960

Year class	Jan.	Feb.	Mar.	April	July	Aug.	Sept.	Oct.	Nov.	Dec.
1959	—	1.6	2.8	—	262.6	466.0	176.8	499.9	375.8	389.9
1958	375.6	15.9	212.2	7.7	903.5	625.8	269.5	386.5	233.4	454.4
1957	488.6	253.7	248.7	110.3	418.1	298.8	398.5	252.9	137.0	124.6
1956	15.3	12.0	6.1	3.9	—	12.0	21.8	6.3	1.5	—
1955	12.4	50.2	4.1	55.8	10.6	12.5	85.8	40.4	10.0	8.9
1954	0.3	1.6	0.1	5.7	—	0.4	5.9	5.0	—	—
1953	0.1	—	—	1.3	—	—	—	—	—	—
1952 & earlier	0.8	4.8	0.3	4.4	—	—	—	1.0	0.3	0.4

MORAY FIRTH AND ORKNEY AREA: NUMBER OF WHITING OF EACH YEAR-CLASS LANDED PER DAY'S ABSENCE BY SEINE-NET BOATS AT ALL SCOTTISH PORTS

1958

Year class	May	July	Sept.	Nov.	Dec.
1957	—	95.6	44.4	139.2	214.0
1956	—	152.0	18.3	—	27.1
1955	246.9	1415.2	846.3	340.5	214.9
1954	127.1	165.6	58.6	103.0	35.8
1953	24.8	—	7.3	47.9	2.5
1952	163.2	126.6	69.5	273.8	25.9
1951	25.8	1.0	12.3	36.5	—
1950 & earlier	2.3	—	2.0	6.7	—

1959

Year class	Jan.	Feb.	June	Aug.	Sept.	Oct.	Nov.	Dec.
1958	—	—	—	35.4	60.8	5.1	95.1	215.9
1957	23.7	37.9	755.4	558.1	342.6	377.4	208.8	89.0
1956	8.2	10.1	121.7	33.8	41.0	28.5	14.9	17.9
1955	96.7	24.9	202.1	284.5	158.9	238.9	99.9	30.7
1954	25.2	3.2	27.3	37.3	15.5	32.9	10.5	3.1
1953	2.2	—	5.0	2.5	2.3	8.7	3.6	1.5
1952	44.4	6.6	72.5	43.0	33.9	21.6	23.4	12.7
1951 & earlier	5.8	1.0	13.3	1.1	1.4	16.6	4.7	2.9

1960

Year class	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1959	—	0.2	—	2.6	1.3	75.9	233.2	447.7	326.6	368.5	143.1	81.8
1958	68.6	19.9	36.1	160.0	125.0	199.2	435.5	371.3	206.1	266.5	70.8	24.8
1957	178.6	56.0	93.5	177.1	174.0	235.3	312.7	214.8	160.1	134.8	74.0	15.8
1956	7.6	1.7	4.3	0.7	2.1	4.4	4.2	—	3.8	2.7	0.2	0.5
1955	23.7	8.2	11.3	17.1	20.8	16.9	29.6	15.2	29.7	4.4	9.5	3.1
1954	1.0	1.0	1.3	3.9	2.2	2.9	3.3	1.8	2.6	—	1.0	—
1953	0.4	0.4	—	0.5	—	0.6	—	—	—	—	0.1	—
1952 & earlier	7.6	1.1	0.5	3.5	8.4	0.9	2.4	—	—	—	0.6	0.2

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